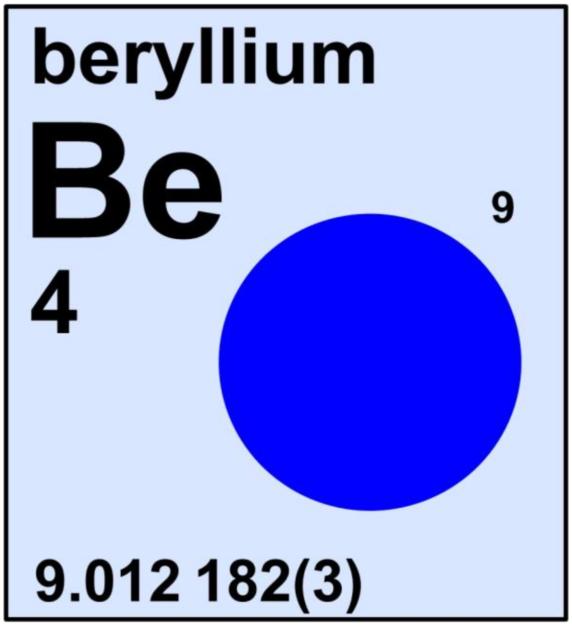
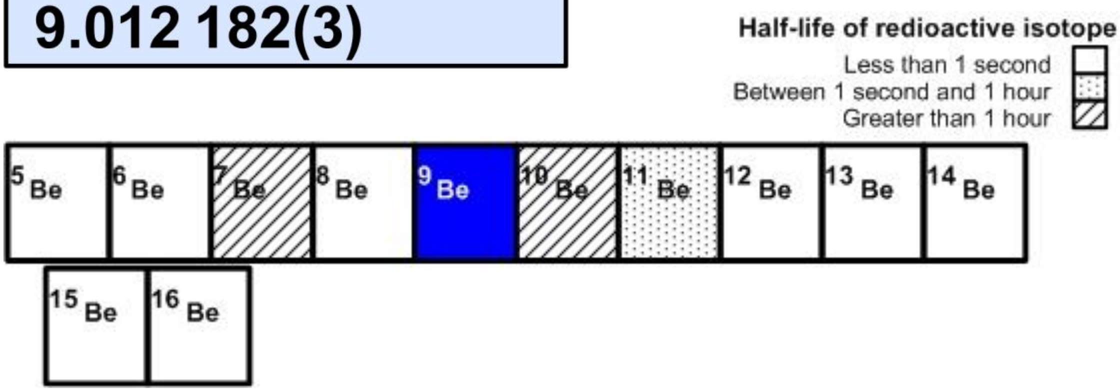
beryllium



Stable isotope	Atomic mass*	Mole fraction
^{9}Be	9.012 1822	1.0000

* Atomic mass given in unified atomic mass units, u.



Important applications of stable and/or radioactive isotopes

Isotopes in geochronology

1) Primordial radioactive Be isotopes are essentially non-existent on Earth, having decayed away over the period of Earth history, which is equivalent to about 3000 times the ^{10}Be half-life. Nonetheless, minute quantities of ^{10}Be (half-life 1.5 x 10^{6} a) and ^{7}Be (half-life 53 d) produced continuously by cosmic rays have been exploited for studies of atmospheric and Earth surface processes in geoscience.
2) Cosmogenic ^{10}Be and ^{7}Be are produced in the atmosphere largely by cosmic-ray spallation of O and N. Because of its relatively short half-life, measurements of cosmogenic ^{7}Be, and especially the ratio of cosmogenic ^{7}Be/^{10}Be, can be used to study rates of atmospheric circulation, mixing, aerosol formation, and particle deposition.
3) Moreover, after settling through the atmosphere, cosmogenic atmospheric Be is deposited on the Earth's surface where it accumulates in soils, sediments, and snow while decaying away. Thus, measurements of cosmogenic Be isotopes in such deposits can be used to examine rates of soil formation, erosion, sedimentation, and snow accumulation on time scales ranging from months (^{7}Be) to millions of years (^{10}Be).

4) Substantial quantities of ^{10}Be and ^{7}Be are formed by cosmic ray interactions with minerals at the Earth's surface, thus providing additional chronometers for geologic processes. In some situations, it is possible to estimate "exposure ages" for rocks in eroding terrains, by comparing measured ^{10}Be concentrations with estimated rates of in situ cosmogenic ^{10}Be production. This method has revealed, for example, that some of the hard-rock canyons and waterfalls in the mid-Atlantic region of the US must have formed rapidly during glacial times, rather than more slowly over the much longer geologic history of the rocks in which they are found (Figure 1b).
5) When combined with other data, cosmogenic Be isotopes can be used to study variations in solar activity, through an inverse relation between solar wind and the flux of galactic cosmic rays reaching the Earth.
6) Anthropogenic ^{10}Be was produced by nuclear bomb explosions, largely through reaction of fast neutrons with ^{13}C, as in atmospheric CO_2. Although the quantity of ^{10}Be produced in this way is small, its presence above natural background concentrations in some environmental samples can potentially provide information about bomb-related processes and contamination.

Figure 1a: Great Falls on the Potomac River near Washington DC.

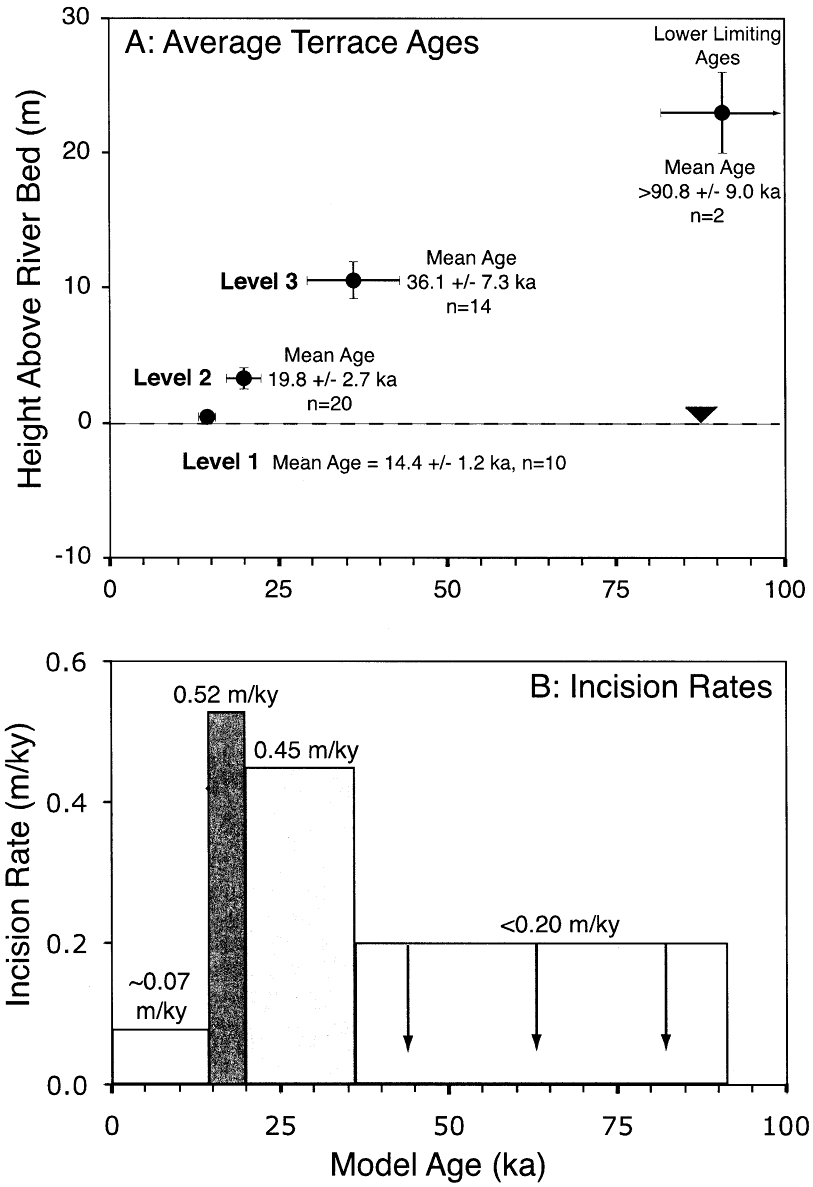


Figure 1b.

Figure 1a and 1b: Rapid erosion of river canyons near the fall line in the eastern US during the last glacial cycle, estimated from concentrations of in situ cosmogenic ^{10}Be. Figure 1b is the estimated exposure ages and implied erosion rates determined from ^{10}Be measurements in rock samples from different heights above the modern level of the Susquehanna River in PA. Erosion rates were highest (0.5 m/ky) during the peak of the last major glacial period, then decreased abruptly to around 0.07 m/ky after glacial retreat. Figure 1a is a picture of the Great Falls on the Potomac River near Washington DC, where similar results were reported. Higher erosion rates are attributed to glacial-age climate conditions promoting larger and more frequent flood events.